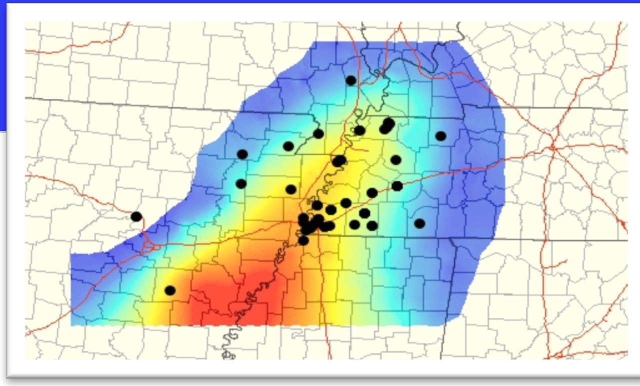

Assessment of Site Conditions and Improvement of Ground-Motion Prediction Equations in the Central United States

Project #: ED2013_17
RES2013-17

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PURPOSE OF THE PROJECT

This proposal is a continuation of a set of previously funded research projects sponsored by the TDOT. The first phase of the previously funded projects focused on determination of the seismic acceleration coefficients at the bedrock and ground surface for West Tennessee (Pezeshk, et al. 1996, Pezeshk et al., 1998). The next phase of the funded project, which ended in September 2003, used the computer program DEEPSOIL to generate time histories and acceleration coefficients at the ground surface at 5 sites (Pezeshk and Hashash, 2003). In the next phase of the funded project, which ended in January 2009 (Pezeshk et al., 2009), we developed the computer program SSHAP (Site Specific Hazard Analysis Program) to obtain accelerations for PGA, 0.2 second, and 1.0 second for a 1,000-year return period (and other return periods as needed) at the ground surface and at the B/C boundary. For a recently completed project, we developed a procedure for site amplification calculations and near fault effects. The purpose of this study is to continue previously funded projects to improve our path attenuation and to examine the site amplification factors developed in previously funded projects using the recently well-recorded data in the central United States.

SCOPE AND SIGNIFICANCE OF THE PROJECT

In the field of earthquake engineering, ground-motion prediction models (attenuation relationships) are frequently used to estimate the peak ground acceleration (PGA) and the pseudo spectral acceleration (PSA). In regions of the world where ground-motion recordings are plentiful, such as western North America (WNA), the ground-motion prediction equations are obtained using empirical methods. In other regions, such as Central and Eastern North America (CENA), where there is insufficient ground-motion data, alternative methods must be used to develop ground-motion prediction equations (GMPEs). The hybrid empirical method is one such method. This method employs the stochastic simulation method to adjust empirical GMPEs developed for a region with abundant strong-motion recordings in order to estimate strong-motion parameters in a region with a sparse database. The adjustments take into account differences in the earthquake source, wave propagation, and site-response characteristics between the two regions.

In 2005, we developed a set of attenuation relationships using the hybrid empirical method (Tavakoli and Pezeshk, 2005). Our model was used and implemented in the 2008 USGS hazard maps, which are used by the American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications. We updated our 2005 model and published Pezeshk et al. (2011), which is currently being used by USGS for development of the 2014 USGS hazard maps. As part of the project, Pezeshk et al. (2011) ground motion prediction equations (attenuation relationships) are being updated to reflect additional information that has become available based on the recent research and data. In particular, it is timely and important to use the recent earthquakes well recorded by the EarthScope transportable array (TA) in the central and south-central United States as well as data recorded by the Advanced National Seismic System (ANSS) in the region. The National Research Council of the National

Academies (2006) advocated dense free-field urban seismic networks, such as the ANSS in the Mississippi embayment, so that, among other reasons, strong-motion records can be correlated with observed damage during large earthquake events. Data from events recorded on these networks are being used to help characterize the effects of the near-surface geological and site conditions on ground motions, with the ultimate goal of utilizing empirical data to improve ground motion estimations for earthquake engineering applications.

EXPECTING OUTCOMES

The following is a list of expected outcomes:

1. A comprehensive literature search and assembly of pertinent information necessary. The deliverable will be a written report with reference to the literature.
2. Review and interpret data from recent recorded central U.S. earthquakes.
3. Examine and determine the appropriate earthquake source, wave propagation, and site-response characteristics of earthquakes in the central U.S. region.
4. Examine ground motion prediction models for the Central and Eastern United States and improve the existing models in light of new data and models for the source, path (Geometric spreading and anelastic attenuation), and site.
5. Improvement of ground motion selection and scaling. To perform linear and nonlinear time history analyses, as needed by the AASHTO and Seismic Specifications, there is a need for realistic time histories. For this objective, previous work will be expanded to provide simplified procedures for earthquake generation and scaling to match the design response spectrum.
6. As part of this task, we will develop a set of time histories at selected locations in consultation with Tim Huff for use at the ground surface within the New Madrid seismic zone.
7. Present the newly formulated ground motion prediction model including site effects in Microsoft Excel format.

TIME PERIODS AND STATUS OF THE PROJECT

The project started on August 1, 2013. The project is scheduled to be completed by December 31, 2016.